AD736401

FTD-HT-23-1123-71

# FOREIGN TECHNOLOGY DIVISION

AIR FORCE SYSTEMS COMMAND

PROCESS FOR THE MANUFACTURE OF A WEAR RESISTANT
AND CORROSION RESISTANT LAYER

by

K. Zabelt and H. Hantzche

FOREIGN TECHNOLOGY DIVISION



[redacted]

Approved for public release;
distribution unlimited.



12

UNCLASSIFIED
Security Classification

**DOCUMENT CONTROL DATA - R & D**

*(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)*

| | |
|---|---|
| 1. ORIGINATING ACTIVITY (Corporate author)<br>Foreign Technology Division<br>Air Force Systems Command<br>U. S. Air Force | 2a. REPORT SECURITY CLASSIFICATION<br>UNCLASSIFIED<br>2b. GROUP |

3. REPORT TITLE

PROCESS FOR THE MANUFACTURE OF A WEAR RESISTANT AND CORROSION RESISTANT LAYER

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Translation

5. AUTHOR(S) (First name, middle initial, last name)

Zabelt, K. and Hantzche, H.

| 6. REPORT DATE | 7a. TOTAL NO. OF PAGES | 7b. NO. OF REFS |
|---|---|---|
| 19 December 1967 | 8 | |

| | |
|---|---|
| 8a. CONTRACT OR GRANT NO.<br>b. PROJECT NO. 7343<br>c.<br>d. | 9a. ORIGINATOR'S REPORT NUMBER(S)<br>FTD-HT-23-1123-71<br>9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) |

10. DISTRIBUTION STATEMENT

Approved for public release; distribution unlimited.

| | |
|---|---|
| 11. SUPPLEMENTARY NOTES | 12. SPONSORING MILITARY ACTIVITY<br>Foreign Technology Division<br>Wright-Patterson AFB, Ohio |

13. ABSTRACT

The purpose of the invention is the manufacture of a layer which contains little material and has little weight and which exhibits a great adhesive stability. The layer is to be used for construction elements impacted by rebounding and slanting blast abrasion. Moreover, the mechanical properties of the construction elements should not be changed by the manfactured layer. The invention therefore is based upon the task of utilizing a plasma spray method for blast abrasion, especially for construction elements that are impacted by slanting and rebounding blast abrasion. It was found that tungsten carbide, aluminum oxide or zircon oxide with additive substances, are applicable for construction elements impacted by blast abrasion, especially slanting and rebounding blast abrasion. Applicability depends on a combination of characteristics. An especially good adhesion of the layers is attained by spraying an intermediate layer of nickel or nickel chromium on the adhesive surface. Through the application of this method, a doubled surface life is obtained for construction elements impacted by blast abrasion. [AA0202917]

DD FORM 1 NOV 65 1473

UNCLASSIFIED
Security Classification

UNCLASSIFIED

Security Classification

| 14. KEY WORDS | LINK A | | LINK B | | LINK C | |
|---|---|---|---|---|---|---|
| | ROLE | WT | ROLE | WT | ROLE | WT |
| Metallurgic Patent | | | | | | |
| Corundum | | | | | | |
| Titanium Dioxide | | | | | | |
| Zirconium Oxide | | | | | | |
| Aluminum Oxide | | | | | | |
| Adhesive | | | | | | |
| Wear Resistance | | | | | | |
| Corrosion Resistance | | | | | | |
| Carbide | | | | | | |
| Protective Coating | | | | | | |

UNCLASSIFIED

Security Classification

FTD-HT-23-1123-71

# EDITED TRANSLATION

PROCESS FOR THE MANUFACTURE OF A WEAR RESISTANT AND CORROSION RESISTANT LAYER

By: K. Zabelt and H. Hantzche

English pages: 8

Source: German Patent No. 72199 (Dec. 19, 1967), pp. 1-4.

Translated by: J. Stock

Approved for public release; distribution unlimited.

| | |
|---|---|
| THIS TRANSLATION IS A RENDITION OF THE ORIGINAL FOREIGN TEXT WITHOUT ANY ANALYTICAL OR EDITORIAL COMMENT. STATEMENTS OR THEORIES ADVOCATED OR IMPLIED ARE THOSE OF THE SOURCE AND DO NOT NECESSARILY REFLECT THE POSITION OR OPINION OF THE FOREIGN TECHNOLOGY DIVISION. | PREPARED BY: TRANSLATION DIVISION FOREIGN TECHNOLOGY DIVISION WP-AFB, OHIO. |

# PROCESS FOR THE MANUFACTURE OF A WEAR RESISTANT AND CORROSION RESISTANT LAYER

K. Zabelt and H. Hantzsche

The invention concerns a method for the manufacture of a wear resistant and corrosion resistant layer by coating on metal carbides or metal oxides by spraying plasma on a base capable of holding the substance.

It is well-known that a wear resistant and corrosion resistant layer can be formed by plasma spraying of tungsten carbide aluminum carbide or zircon oxide with additives onto a surface capable of holding the substance while taking care to apply definite mixing ratios and welding parameters (German Democratic Republic 36284; 43958), so that a wear resistant and corrosion resistant layer is formed. These layers are suitable for construction elements that are exposed to sliding abrasion.

As is known, layers of this type are not suitable for construction elements that are exposed to blast abrasion especially slanting and rebounding blast abrasion as they do not permit the production of layers associated homogeneously with the adhesive base (German Democratic Republic 45246; 50710). During the occurrence of blast abrasion, the hard carbides and oxides are forced out so that the stability and corrosion resistance of the abrased surface is decreased. Besides, in many cases along with blast abrasion, further stresses

occur such as rusting beneath the surface, corrosion by inability to withstand the water or acid condensation point, as well as thermodynamic stresses occurring during the processes of starting and operation.

For this reason construction elements of this type are provided with layers by welding coating (German Democratic Republic 45246; 44289), which are not suited from a standpoint of material and weight and therefore are not suited for thin walled construction elements subjected to the danger of warping. Moreover, the mechanical properties of the construction elements change through changes in texture and therefore lead to a decrease in the stability intended by the designer.

The purpose of the invention is the manufacture of a layer which contains little material and has little weight and which exhibits a great adhesive stability. The layer is to be used for construction elements impacted by rebounding and slanting blast abrasion. Moreover, the mechanical properties of the construction elements should not be changed by the manufactured layer.

The invention therefore is based upon the task of utilizing a plasma spray method for blast abrasion, especially for construction elements that are impacted by slanting and rebounding blast abrasion.

It was found that tungsten carbide, aluminum oxide or zircon oxide with additive substances, are applicable for construction elements impacted by blast abrasion, especially slanting and rebounding blast abrasion. Applicability depends on a combination of the following characteristics:

a) That the adhesive base of the construction element is prepared by scouring, sandblasting and blowing off with compressed air.
b) That the mixing parameters of the following spray materials are maintained:

| | | Grain magnitude (μm) |
|---|---|---|
| 1. | Tungsten carbide | 30 to 60 |
| | with 10 to 15% cobalt | 40 to 80 |
| 2. | Tungsten carbide | 30 to 60 |
| | with 10 to 20% nickel | 30 to 90 |
| 3. | Cast tungsten carbide | 30 to 60 |
| | with 10 to 15% cobalt | 40 to 80 |
| 4. | Cast tungsten carbide | 30 to 60 |
| | with 10 to 20% nickel | 40 to 90 |
| 5. | Tungsten carbide | 30 to 60 |
| | with 10 to 15% cobalt | 40 to 80 |
| | and 1 to 20% cast tungsten carbide | 30 to 60 |
| 6. | Tungsten carbide | 30 to 60 |
| | with 10 to 20% nickel | 30 to 90 |
| | and 1 to 20% cast tungsten carbide | 30 to 60 |
| 7. | Stabilized zircon oxide | 30 to 50 |
| 8. | Aluminum oxide | 30 to 50 |
| | with 1 to 3% titanium oxide | 30 to 50 |
| 9. | Standard corundum | 30 to 50 |

c) That the following spraying parameters are maintained: spraying distance 10 to 120 mm, spraying thrust 6 to 9 m/min, temperature of the construction element, maximum 150°C. Ratio of stabilizing gases Ar-$N_2$ 65:35 to 35:65, quantity of stabilizing gas 2500 $l$/h, stabilizing gas enthalpy 2600 to 3500 kcal/kg of gas, voltage 65 to 72 V.

An especially good adhesion of the layers is attained by spraying an intermediate layer of nickel or nickel chromium on the adhesive surface.

Through the application of this method, a doubled surface life is obtained for construction elements impacted by blast abrasion.

The invention will be more thoroughly explained through the use of an operational example. The pertinent drawing shows schematically an installation for plasma spraying.

The construction element 1 being provided with a wear resistant and corrosion resistant layer 7, for example a blade of an induced draught gyroscope exposed to slanting blast and rebounding blast abrasion, is prepared in assembly ready condition by scouring, sandblasting and blowing off with compressed air, and is clamped in a cooling device 2. The construction element 1 is cooled during plasma spraying in such a manner that a temperature of 150°C is not exceeded. This is accomplished by applying water or compressed air 3 to the rear side of the construction element.

As a spraying material for the above cited blade subjected to abrasion, tungsten carbide with a grain magnitude of 40 to 90 μm and with an additive of 10 to 20% nickel with a grain magnitude of 40 to 90 μm, is used.

The spraying of a layer takes place with an ordinary plasma burner 4, which is arranged on a moveable tiltable arm 5.

An Ar-$N_2$-gas mixture in a ratio of 65:35 to 35:65 is suitable as a stabilizing gas. The quantity of stabilizing gas amounts to 2500 $l$/h and the enthalpy amounts to 2600 to 3500 kcal/kg of gas.

The distance to be maintained between the nozzle of the plasma burner 4 and the construction element, amounts to 100 to 120 mm. The spraying of the areas subject to abrasion on the blade, takes place with a thrust speed of 6 to 9 m/min so that a uniform layer is obtained. After each longitudinal movement on the guide 6, a latitudinal shift of the plasma burner 4 takes place and a spraying of a new abrasion path until the required layer thickness of 0.5 mm is attained.

After the spraying of the first abrasion zone, the plasma burner or the cooling device is swivelled and further zones subject to abrasion can be sprayed.

After the end of the plasma spraying, the blade subject to abrasion can be installed in the induced draught gyroscope without requiring an additional balancing.

The stated mixing ratios of the spraying materials are advantageously utilized through considering the stated welding parameters for construction elements exposed to the stresses shown in Table 1 (see page 3).

PATENT CLAIMS

1. A method for the manufacture of an abrasion resistant and corrosion resistant layer by coating on metal carbides or metal oxides by means of plasma spraying onto an adhesive base, characterized by the use of tungsten carbide, aluminum oxide or zircon oxide with additive materials for blast abrasion, especially for construction elements impacted by slanting blast abrasion and rebounding blast abrasion, through a combination of the following characteristics:

a) That the adhesive base of the construction element is prepared by scouring sandblasting and blowing off with compressed air.
b) That the mixing parameters of the following spraying materials are maintained

| | | Grain magnitude (μm) |
|---|---|---|
| 1. | Tungsten carbide | 30 to 60 |
| | with 10 to 15% cobalt | 40 to 80 |
| 2. | Tungsten carbide | 30 to 60 |
| | with 10 to 20% nickel | 30 to 90 |
| 3. | Cast tungsten carbide | 30 to 60 |
| | with 10 to 15% cobalt | 40 to 80 |
| 4. | Cast tungsten carbide | 30 to 60 |
| | with 10 to 20% nickel | 40 to 90 |
| 5. | Tungsten carbide | 30 to 60 |
| | with 10 to 15% cobalt | 40 to 80 |
| | and 1 to 20% cast tungsten carbide | 30 to 60 |

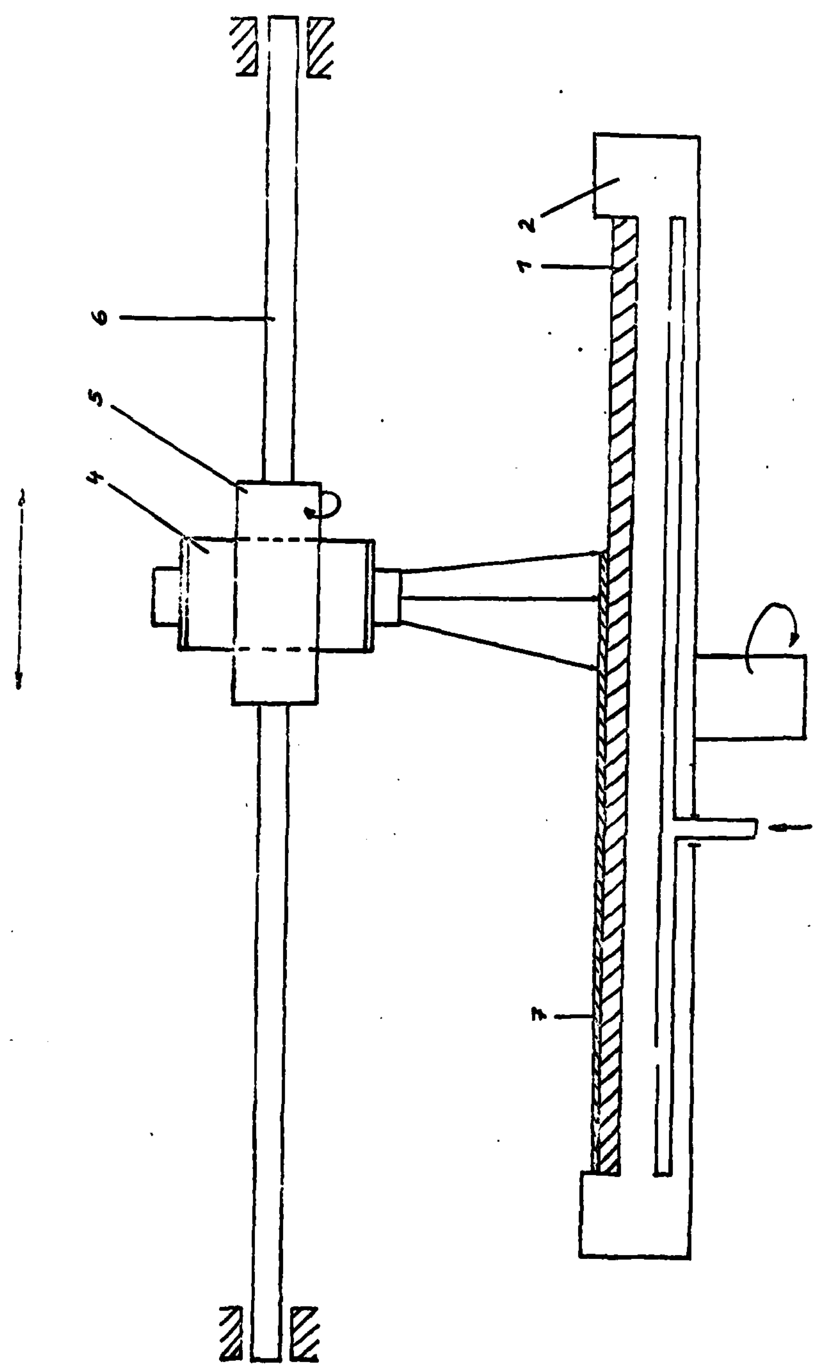
| | | |
|---|---|---|
| 6. | Tungsten carbide | 30 to 60 |
| | with 10 to 20% nickel | 30 to 90 |
| | and 1 to 20% cast tungsten carbide | 30 to 60 |
| 7. | Stabilized zircon oxide | 30 to 50 |
| 8. | Aluminum oxide | 30 to 50 |
| | with 1 to 3% titanium | 30 to 50 |
| 9. | Standard corundum | 30 to 50 |

c) That the following spraying parameters are maintained, spraying distance 100 to 120 mm, spraying thrust 6 to 9 m/min, temperature of the construction element, 150°C, ratio of the stabilizing gas of a mixture of $Ar-N_2$ 65:35 to 35:65, quantity of stabilizing gas 2500 l/h, stabilizing gas enthalpy 2600 to 3500 kcal/kg of gas, voltage 65 to 72 V.

2. A method according to plane 1, characterized in that an intermediate layer of nickel of nickel chrome is sprayed onto the adhesive base.

Table 1.

| Type of abrasion | Mixing ratio | Grain magnitude (μm) |
|---|---|---|
| Blast abrasion (Erosion through quartz sand) | Cast tungsten carbide with 10 to 15% cobalt | 30 to 60<br>40 to 80 |
| Blast abrasion and corrosion through inability to withstand the condensation points | Cast tungsten carbide with 10 to 20% nickel | 30 to 60<br>40 to 90 |
| Blast jet abrasion and dynamic stresses at low flue gas velocity | Tungsten carbide with 10 to 15% cobalt or 10 to 20% nickel | 30 to 60<br>40 to 80<br>30 to 90 |
| Slanting and/or rebounding blast abrasion | Tungsten carbide with 10 to 15% cobalt or 10 to 20% nickel and 1 to 20% cast tungsten carbide | 30 to 60<br>40 to 80<br>30 to 90<br>30 to 60 |
| Blast abrasion dynamic stresses corrosion and slippage abrasion | Stabilized zircon oxide or aluminum oxide with 1 to 3% titanium oxide or standard corundum | 30 to 50<br>30 to 50<br>30 to 50<br>30 to 50 |



2
1
6
5
4
3
7